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Lóránt Tavasszy

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Lóránt Tavasszy

Delft University of Technology, Delft, The Netherlands

ABSTRACT
Electrification of heavy-duty road freight transport is an important step to reduce the carbon emissions of the transport sector. Major investments are being considered for the transitioning of truck fleets with heavy batteries as well as new charging infrastructure. Until recently the emphasis for infrastructure has been on charging stations, while dynamic charging is an important alternative to consider. This paper summarizes recent research results about dynamic charging and argues for integrative network design, where stationary and dynamic technologies work together. It concludes with main research & development challenges.

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Electrification; heavy-duty trucks; dynamic charging; electric road systems; network design

Context: development of the battery-electric truck landscape

To support the electrification of Europe's transport system, recently the Council of the European Union has adopted the Alternative Fuel Infrastructure Regulation (AFIR). Amongst others, the AFIR asks for investments in charging stations for battery-electric heavy-duty trucks. It foresees high-capacity recharging stations every 60 km along the core of the Trans-European Network for Transport by 2025 (European Commission 2021). The required investments run into billions of euros, and the operational challenges to implement such a network of charging stations are vast. Not only is it necessary to upgrade the electricity grid, but also vehicles need to be equipped with batteries of unprecedented size, weight, and cost. Currently, unavailability of charging infrastructure and high costs of truck batteries are the main supply- and demand-side bottlenecks for the expansion of the battery-electric truck landscape.

Dynamic charging: a new opportunity

During the past decade, charging technologies have advanced, and new knowledge has developed, which could promise a faster and easier implementation. In addition to using charging stations, trucks can also charge while moving, known as dynamic

CONTACT Lóránt Tavasszy L.A.Tavasszy@tudelft.nl Delft University of Technology, P.O. Box 5015, 2600 GA, Delft, The Netherlands

charging or Electric Road Systems. The system involves either catenary (overhead) lines, such as in rail transport; conductive charging via roadside rails, such as in metro systems; or induction charging with wireless charging coils embedded in the pavement, comparable to what is in use today for mobile phones. Solutions similar to ERS are known in road passenger transport and include the trolleybus and the trackless tram. While there are subtle differences in technology, both are seen as promising alternatives (see e.g. Stavropoulos et al., 2022; Newman 2024).

Dynamic charging has important potential advantages. Firstly, batteries become smaller, as the truck only needs to operate using its batteries while away from the charging network. Studies show that this reduction can be as much as 2/3 of the battery size needed with stationary charging (de Saxe et al., 2023). This leads to cost savings and mitigates the negative effect that batteries have on payload. Strategically, it strengthens the sector's independence from rare raw material providers. Secondly, time savings can be achieved by drivers, as they do not need to stop for charging. Given the many time windows involved in planning truck trips, it is expected that charging will disturb route planning and make trips less efficient. As driver wages amount to about 40% of transport costs (Persyn et al., 2019) this saving will also benefit consumers. The third impact is that it can reduce the overall investment need for stationary charging infrastructure at depots and public stations. However, as it provides a different service for specific target groups, it is a complementary addition to the charging landscape (Rogstadius et al., 2023). Finally, it is expected that it will reduce the load on the energy grid from the transport sector (Gaete-Morales et al., 2023).

The key drawback of the system is that its introduction is more complex than that of stationary charging, concerning technology, logistics organization, and governance. In-pavement inductive charging still needs testing for its effect on costs of construction and maintenance. Logistics service providers may prefer a simple landscape of alternative charging technologies. Realization and operation of charging infrastructure will need to be initiated by government action, with involvement of private actors for concessioning, building, financing, and maintenance, in addition to the challenge of realizing charging stations.

Recent studies suggest net societal benefits

Recently there has been a wave of studies and pilots by national governments, road authorities, universities, and industry arriving at the conclusion that ERS could be an important addition to charging stations, allowing an accelerated roll-out of electrification infrastructure at a lower cost (Börjesson, Johansson, and Kågeson 2021; Deshpande et al., 2023; PIARC 2023; Rogstadius, Alfredsson, and Sällberg 2023). Pilots have been conducted in several countries around the world, and ideas have formed about larger networks. Liao et al. (2024) find that the battery size savings alone would be sufficient to fund a dynamic charging network of 15,000 km in length, largely obviating the need for investment in public heavy-duty stationary charging along these highway corridors. This is close to the combined size of the motorway networks of Germany, the Netherlands, and Belgium. A sensitivity analysis shows that less favorable conditions would still allow building an extensive network of more than 5000 km in length. The relative position of dynamic charging ultimately depends on the expected impact on the total costs of ownership (TCO) for different types of fleets and operations. This impact is influenced by charging prices, infrastructure and battery costs, and the adoption of autonomous driving (Carlsson et al., 2025; Rogstadius et al., 2024). These studies together indicate that dynamic charging is a technology of strategic importance, complementing stationary charging infrastructure for both short- and long-distance movements.

Nearby R&D challenges

The benefits of dynamic charging would primarily be incurred by the transport sector, while infrastructure investments require initiative from national governments. Business models are needed that allow the transfer of part of these benefits from carriers to those commissioned to build, maintain, and exploit charging infrastructure. In addition, new research needs exist concerning technology development. Technology readiness levels (TRLs) range from 6 to 8, which implies room for development in operational systems. Inductive charging would have co-benefits from urban freight and passenger transport, as it also allows charging at parking places and for smaller vehicles. Impacts on the energy system need to be assessed. New network designs are needed, which consider mixed forms of charging and routing profiles in different segments of the road haulage industry. Finally, research-intensive living labs such as the one in Germany could spur the development of international technological standards, common service models, and corridor-level investment programs.

Disclosure statement

No potential conflict of interest was reported by the author(s).

References

Börjesson, M., M. Johansson, and P. Kågeson. 2021. "The Economics of Electric Roads." *Transportation Research Part C: Emerging Technologies* 125:102990.

de Saxe, C., D. Ainalis, J. Miles, P. Greening, A. Gripton, C. Thorne, and D. Cebon. 2023. "An Electric Road System or big Batteries: Implications for UK Road Freight." *Transportation Engineering* 14:100210.

Deshpande, P., C. de Saxe, D. Ainalis, J. Miles, and D. Cebon. 2023. "A Breakeven Cost Analysis Framework for Electric Road Systems." *Transportation Research Part D: Transport and Environment* 122:103870. https://doi.org/10.1016/j.trd.2023.103870.

European Commission. 2021. "Proposal for a regulation of the European Parliament and of the Council on the deployment of alternative fuels infrastructure" (COM/2021/559), Brussels: EC.

Gaete-Morales, C., J. Jöhrens, F. Heining, and W. P. Schill. 2023. Power sector effects of alternative options for electrifying heavy-duty vehicles: go electric, and charge smartly. arXiv preprint arXiv:2303.16629.

Carlsson J., K. Paulsson, S. Peterson, A. Petersson, K. Ounsi, N. Enberg, and M. Andersson. 2025. *How will the development of batteries affect ERS profitability?*. Colliers Deliverable. Trafikverket. (DiVA, id: diva2:2014612).

Liao, X., M. Saeednia, M. Nogal, and L. A. Tavasszy. 2024. "Scaling-Up Dynamic Charging Infrastructure: Significant Battery Cost Savings." *Transportation Research Part D: Transport and Environment* .

Newman, P. 2024. "Trackless Trams: An Emerging Transformative Opportunity." *Journal of City Climate Policy and Economy* 2 (2): 241–250.

Persyn, D., J. Díaz-Lanchas, and J. Barbero. 2019. “Estimating Road Transport Costs between EU Regions (No. 04/2019).” JRC working papers on territorial modelling and analysis.

PIARC. 2023. *Electric Road Systems: A Route to net Zero*. France: PIARC.

Rogstadius, J., M. Alaküla, P. Plötz, F. Márquez-Fernández, and L. Nordin. 2024. *2035 Joint Impact Assessment of Greenhouse Gas Reducing Pathways for EU Road Transport*. Stockholm: RISE.

Rogstadius, J., H. Alfredsson, and H. Sällberg. 2023. “Electric Road Systems: A No-Regret Investment with Policy Support” Research Square. https://doi.org/10.21203/rs.3.rs-3372572/v1

Stavropoulou, E., C. Iliopoulou, and K. Kepaptsoglou. 2022. “Battery-Assisted Trolleybus Network Design: Model and Application.” *Journal of Transportation Engineering, Part A: Systems* 148 (9): 04022063.